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INSERT FOR COLUMNS USED FOR HEAT AND MATERIALS EXCHANGE

[Einsatz fuer zum Waerme- und Stoffaustausch verwendete Kolonnen]

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Insert for Columns Used for Heat and Materials Exchange

In columns in which heat and materials exchange processes take place, to obtain small flow resistances, a uniform and almost complete wettability of the surfaces, as well as homogeneous exchange conditions in the entire volume, inserts (1) are used, which consist of rectangular plates (3) arranged vertically in the column (2), which can be separated or can be permanently connected along the longer edges. Three, four, or six plates (3) can be interconnected, whereby flow channels (6) with triangular, rectangular, or hexagonal profile are formed. In each plate (3) are configured cutouts (7, 8) with a regular geometric profile, which are arranged in pairs along the plate (3) and are bent off at both sides of the plate, so that the bending lines of these cutouts are inclined toward the plate edge at an acute angle. The cutouts (7, 8) form locks in the flow channel (6) formed by the plates (3), which are arranged at the same height or at different heights along the length of the channel.

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PATENT CLAIMS

1. An insert for columns used for heat and materials exchange consisting of stable elements, which form flow channels for the media in the column parallel to the vertical column axis and which are equipped with controls and vortex elements for the flow, wherein the elements of the insert (1) are smooth, corrugated, or perforated rectangular plates (3), which are in contact along the longer edges and are connected at the corners by means of fittings (4), whereby a system of flow channels (6, 6') with a profile of regular geometric figures is formed over the cross section of the insert (1), and wherein each plate (3)

has any desired number of cutout pairs (7, 8), which are bent off in each pair toward both sides of the plate (3).

2. The insert of claim 1, wherein the bending lines of the subsequent cutout pairs (7, 8) of the same plate (3) are parallel to each other

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and are inclined with respect to the edge of this plate at an acute angle of preferably 45°.

3. The insert of claim 1, wherein the bending lines of the neighboring cutout pairs (7, 8) of the same plate (3) are inclined in opposite direction with respect to the edge of this plate, whereby a mirror-image arrangement is produced.

4. The insert of claim 1, wherein the bent-off cutouts of the plate (3) have are shaped as right-angled triangles (8) or trapezes (7) and are preferably bent off at a right angle with respect to the surface of the plate (3).

5. The insert of claim 1, wherein the strips of the essentially trapeze-shaped cutouts (7), which are bent off from the neighboring plates (3) and which form a flow channel, in particular a channel with triangular cross section, are arranged at the same height, so that their edges have a specific distance to each other or make contact at the center of gravity of the triangular cross section of the channel.

6. The insert of claim 1, wherein the strips of the essentially

triangular cutouts (8), which are bent off from the neighboring plates (3) and form the flow channel, in particular a channel with a triangular cross section, are arranged at different heights and form outlet openings with a screw-shaped profile.

7. The insert of claim 1, wherein connecting deflections for a mutually detachable connection of the plates (3) are configured along the longer edges of these plates.

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8. An insert used for heat and materials exchange columns consisting of stable elements, which form flow channels for media in the column parallel to the vertical column axis and which are equipped with controls and vortex elements for the flow, wherein the elements of the insert (1) are pipe profiles (10) in the form of regular geometric figures, which are composed of flat rectangular plates (3) connected permanently along the longer edges of these plates, so that these profiles are connected at the corners via fittings (4), and the plates (3) have cutouts (12) in the form of regular geometric figures, which are arranged in pairs and are bent off in each pair at both sides of the plate (3).

9. The insert of claim 8, wherein the cutouts (12), which are arranged at the same height in the interior of the pipe profile (10), are permanently connected to each other approximately in the axis of this profile.

10. The insert of claim 1 or 8, wherein the fittings (4) of the plates (3, 3') are ring elements with locks (4').

11. The insert of claim 1 or 8, wherein the plates (3, 3') are each provided with two cutouts (5, 5') at their shorter sides.

12. The insert of claim 1 or 8, wherein additional cutouts (7', 8', 12') in the form of any desired geometrical figure are provided in the cutouts (7, 8, 12) of the plates (3, 3'), which are bent off from the surface of these curvatures.

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Insert for Columns Used for Heat and Materials Exchange

The invention concerns an insert for columns used for heat and materials exchange, which are used in absorption, extraction, distillation, mist elimination, and steam elimination, the purification of gases, as well as for a membrane-free heat exchange.

Different designs of inserts including their components for optimizing the materials and heat exchange processes are known in column apparatus equipped with the inserts.

Of great importance for the kinetic sequence of the materials and heat exchange are, inter alia, the conditions of the flow and the mutual contact of the phases as well as the hydrodynamic conditions of the insert, which determine the effectiveness and economy of the process. Of fundamental importance are therefore the flow resistances, a simultaneous and complete wettability of the surfaces, as well as the largest possible effective surfaces of the inserts. The inserts must therefore ensure an intensive materials and heat exchange, which is connected with a large contact area of the phases and minimal flow resistances.

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For these opposing conditions are sufficient, on the one hand, ring elements in the form of bulk fillings or transfer fillings and, on the other, components, which are configured either as

inserts with rigid but detachable assembly of the same component parts with a specific position in the insert, or as unitary components adapted to the measurements of the apparatus.

To the ring elements belong the so-called Raschig rings with smooth or corrugated surface as well as with modifications in the form of ribs, locks, et cetera in the interior, also Lassing rings with single or double locks, Dixon rings of wire netting without or with a lock, Pall rings with rectangular cutouts in the lateral surface, which are bent off in the shape of a deflection in the direction toward the axis, and forming rings with locks and circular-shaped cutouts in the lateral surface.

From the Polish patent publications 55 193, 70 169, 74 693, 86 686, 100 420, 100 697, 101 135, 101 927 and 105 806 are known filling elements whose common property is a ring-shaped configuration. They are generally produced by rolling a strip, in which have been previously cut openings of different shapes. The cutouts produced in this way are bent off in the direction toward the axis, whereby the free flow cross section is dimmed. These cutouts form controls for the medium as well as vortex elements for the flow and are arranged individually or in several rows on the lateral surface of the ring.

From the Polish patent publication 58 460 is known a column insert consisting of two or more perforated undulated surfaces, on which are attached on both sides alternating transverse locks.

These surfaces are rigid, connected mutually in parallel, and positioned vertically in the column.

In the Polish patent publication 63 575 is described a column filling consisting of several layers, wherein each layer forms a

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grid system of mutually penetrating strips that build bent-off strips at the level, and the neighboring layers are positioned in such a way that their strips are inclined in opposite directions.

Other column fillings for materials exchange known from the Polish patent publication 82 621 consist of a series of metal plates or plastic plates, which are distributed in parallel sectors of strips or cutouts and have the shape of undulated lines or jagged lines, which are in planes vertical to the plate. The strips or cutouts of a plate penetrate accordingly the strips or cutouts of the neighboring plates.

From the Polish patent publication 97 242 is known a column filling designed in the form of stacks, which has contact surfaces for the phases arranged parallel to the column axis, wherein inserts that stir up the flow are arranged between these surfaces.

In the Polish patent publications 100 676 and 101 59 are described components of fillings or inserts, which are configured as horizontal outflow trays or as vertical channels with flow control. The trays or channels are arranged at mutual angles

and form (seen in the transverse direction) a zig-zag profile. The flow controls are configured as cut and bent-off cutouts in the shape of regular geometric figures or projections.

From the Polish patent publications 75 351 and 84 623 are known column filling elements configured as any desired spiral-shaped rolled strips with cutouts in the form of different types of geometric figures, which are bent away alternating inwardly and outwardly from the spiral, so that the height of the bent-off cutouts determines the distance between the rolls of the strips.

A column filling is also known (German patent publication 1 181 672) consisting of vertically positioned parallel sheet

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packs, wherein one layer is shifted with respect to the other by an angle of 90° and each sheet is previously cut and stretched, so that a system of rhombus-shaped openings is formed.

The known so-called PANAPAK filling consists of two previously cut and stretched sheet strips, which have rhombus-like openings. The sheet is welded in a "V" mold. These elements are positioned with the tips upward and form in this way a filling insert.

The known so-called SPRAYPAK filling has a large free cross section and consists of a grid strip of a few millimeter width, which is inserted in the form of rectangular stacks in the column.

The known so-called SULZER filling consists of cylindrical

multilayer segments made of parallel folded wire grid strips. The neighboring segments in the interior of the column are mutually rotated by 90°. The folds are inclined in the direction of the column axis, so that the subsequent strips have different directions of fold inclinations.

In the known POLPAK filling, packs of strips with different widths are wound in screw-like manner and positioned parallel to the gas and liquid flow. The strips are made of metal, lattice work, or plastic.

("Inzynieria i Aparatura Chemiczna," 1975, No. 3, p. 15-22)

A disadvantage of the ring fillings, which are used as bulk fillings or transferred fillings, is the irregular distribution of the liquid and the wetting over the entire height of the filling as well as the large resistance of the gaseous phase. The rings with enlarged surface in the form of cutouts do not allow a free flow of the gaseous phase in the interior of the ring due to the small ratio of the surface of the openings with respect to the total outer surface of the rings. As a consequence, a large part of the gas flows around the exterior of the rings,

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so that the inner surface participates only to a limited extend in the material exchange.

Furthermore, as a consequence of the irregular distribution of

the liquid and the gas, the ring elements effect the production of numerous and undesired free channels in the filling. The ring elements also retain a specific quantity of the liquid, which therefore does not participate in the exchange process. They also allow a free passage of the liquid flows.

Disadvantageous of the fillings in the form of inserts, in particular the plane-parallel and folded ones, is the necessity of providing space holders and vortex elements to effect the turbulence of the flow. In this way are multiplied the labor and construction costs and the column weight is increased.

Another disadvantage of these fillings, in particular of the stack fillings, is a limited mixing of the agents over the cross section of the column, which leads to the formation of single channels when there is insufficient wetting, through which the gas flows, without participating in the materials exchange. This has a disadvantageous influence on the performance of the exchange process.

When insert elements are used, which have a system of openings, in particular in horizontal surfaces, then the gaseous and steam phase cannot contact satisfactorily the liquid phase, whereby the distribution capability of the insert is reduced.

The object on which the invention is based consists in creating an insert with large effective surface per volume unit with small flow resistance and uniform distribution of the liquid, wherein a

good contact between the liquid phase and the gaseous phase should be achieved to ensure a high performance of the materials and heat exchange process.

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This object is attained in accordance with the invention by way of a filling configuration or an insert consisting of elements, which are configured as smooth, folded, or perforated rectangular plates, which are in contact along the longitudinal edges and form in the insert cross section a system of flow channels with a profile of regular geometric figures. These plates are connected at the corners with pipe fittings, preferably ring fittings. Each plate has any desired number of cutout pairs, preferably in the form of trapezes or right-angled triangles, which are bent off in each pair to both sides of the plate. The bending lines of the next cutout pair of the same plate are parallel to each other and are inclined with respect to the edge of this plate at an acute angle of preferably 45°.

In another embodiment, the bending lines of the neighboring cutout pairs of the same plate are inclined in opposite direction with respect to the edge of this plate, and are therefore mirror-image to each other. The cutouts in the plates are bent off at any desired angle, preferably at a right angle.

The cutout pairs with trapeze profile, which are bent off from neighboring plates and form a flow channel, in particular with a

triangular cross section, are arranged at the same height and make contact at points in the center of gravity of the triangular cross section of the channel.

The cutout pairs with triangular configuration, which are bent off from the neighboring plates and form a flow channel, in particular a triangular cross section, are mounted in the subsequent plates at different heights and create in this way outflow surfaces with a screw-shaped profile in this channel. The plates have at their shortest side two cutouts per ring fitting. Along the longer sides, they are equipped in a known way with deflections, for example, in the form of channels,

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for the mutually detachable connection of the plates.

In another embodiment, the filler insert of the invention consists of flat rectangular plates, which are connected permanently in a known way along the longer edges and form the closed pipe profiles in the form of regular geometrical figures. These profiles are connected at the corners via fittings, preferably ring fittings.

The plates have cutouts in the shape of regular geometrical figures, which are arranged in pairs and are bent off for each pair toward both sides of the plate, whereby outlet surfaces are formed in the interior of the profile. These cutouts arranged at the same height in the interior of the pipe profiles are

permanently connected by points approximately in the axis of this profile. In the cutouts are configured, in addition, cutouts in the shape of any desired geometric figure, which are bent off from the cutout surfaces. A transverse lock is provided in the ring fittings.

The insert in accordance with the invention has the following advantages:

Small flow resistances, the elimination of sludge deposits on the insert elements, and a reduction of the insert mass by approximately 60% with reference to a filling of Raschig rings with cross lock, and by approximately 40% with reference to the Raschig rings without lock. A mass of 1 m^3 in Raschig rings of 100 x 100 mm amounts to 750 kg. The insert with the triangular arrangement, which corresponds to this ring measure, has for 1 m^3 a mass of 450 kg.

The insert in accordance with the invention also ensures homogeneous conditions for the materials and heat exchange over the entire volume as well as a uniform and almost complete wettability of the surfaces. The insert also causes a strong turbulence of the gaseous phase and creates conditions for a very good contact between both media that are under materials exchange, which increase the overall performance of the exchange process.

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The invention will be explained in more detail based on the drawings, wherein:

Fig. 1 shows an insert in axial section,

Fig. 2 shows the insert of Fig. 1 from above,

Fig. 3 shows the front view of the insert plate,

Fig. 4 shows the plate of Fig. 3 in a lateral view,

Fig. 5 shows the plate of Fig. 3 form above,

Fig. 6 shows the section A-A in Fig. 3,

Fig. 7 shows unwound plates in front view,

Fig. 8 shows pipe profile of three plates from above, and

Fig. 9 shows another arrangement of the plates on the column apparatus.

As is shown in Figs. 1 to 6, the insert 1 is arranged in the housing 2 of a column. The basic components of the insert are flat, rectangular plates 3, which are mounted vertically and which make mutual contact along the longer sides, six per corner. The plates 3 are attached at the corners by means of ring fittings 4, which penetrate in the corresponding cutouts 5 at the shorter plate sides. In an insert 1 formed in this way, all three plates 3 form a vertical main flow channel 6 with the profile of a right-angled triangle. Between three such channels is produced a similar additional flow channel 6'.

In each plate 3 is introduced any desired number of cutouts 7 with trapeze profile or cutouts 8 with triangular profile, which

are shown in Figs. 3 to 5 with dotted lines, which are arranged by pairs along the plate 3 and wherein each pair is bent off at both sides of the plate 3 at a right angle to the plate surface. The bending lines of the cutouts 7 and 8 are parallel to each other in each pair and are inclined toward the plate edge 3 at an acute angle, preferably of 45°.

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In one and the same plate 3, the bending lines of the subsequent cutout pair 7 or 8 are parallel to each other and inclined in the opposite direction toward the plate edge, so that they are in mirror-image to each other.

The plates 3 have in the longer edges semicircular thickenings 2, which reinforce the plates. At the shorter sides they are provided with rectangular cutouts 5 for the introduction of the ring fittings 4, which form the upper and lower attachment of the plates 3.

In the triangular flow channel 6, the trapeze cutouts 7 of three plates 3 are arranged at the same height and leaning toward one side, wherein they make contact at points in the center of gravity of the triangle formed by these plates, whereby this channel is closed over the cross section. The analog trapeze cutouts 7, instead, which are bent off outwardly from the plates 3 of the channel 6, belong to the additional channel 6 and form a lock, which is identical to that of the channel 6.

In this way is produced an additional fourth channel via the interconnection of three triangular sets of plates 3, which form three basic channels between the basic channels, wherein are utilized the walls of the plates 3 and the cutouts 8 or 7, which are bent off from them.

The triangular cross sections 8 can be arranged at different heights in the plates 3, whereby these cutouts form a cascade-like lock system in the triangular flow channel and cause a spiral-screw-like movement of the liquid and the gas.

In another embodiment (Fig. 8), the insert consists of elements in the form of rigid pipe profiles 10 with triangular profile, which are maintained by the permanent connection of the plates 3 along the longer sides, wherein at the connection point the edge 11, which forms the reinforcement of the profile 10, is thickened.

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In each profile 10 are configured cutouts 5, in which the ring fittings 4 are introduced during mounting.

In the walls of the pipe profiles 10, that is, in the plates 3, are configured trapeze cutouts 12 or triangular cutouts, which are not shown in the figure, and whose arrangement along the walls and angle arrangement are similar to the cutouts 7 or 8.

The pipe profiles are interconnected at the corners by ring fittings 4, whereby a rigid insert construction in the form of a

honeycomb is formed, so that an additional flow channel is produced between three connected pipe profiles in similitude to the triangular arrangement of plate 3, which is delimited by the outer walls of these pipe profiles.

In another embodiment (Fig. 9), the pipe profiles can have a square or hexagonal cross section. Additional cutouts 7', 8', and 12' with profiles of any desired geometrical figure can be configured in the sections 7, 8, and 12, so that these cutouts are bent off with respect to their corresponding cutouts.

The ring fittings 4 consist of straight pipe sections and are equipped with a lock to reduce the flow of liquid along the edges of the plate 3 or pipe profiles 10, which are in contact.

As shown in Fig. 9, in another arrangement, 3 plates 3 are interconnected, whereby hexagonal flow channels are formed, or four plates 3 are interconnected to form square channels.

In another embodiment, the plates 3 are disposed parallel to each other and form straight or spiral-shaped filling systems. For the mutual connection of the plates 3 are configured deflections (which are not shown) in a known way along their longer sides,

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for example, in the form of small channels, profile depressions, et cetera. These deflections are connection elements as well as also reinforcements of the plates 3.

The insert according to the invention can consist of sets of

plates 3 (not shown), which form two-armed, three-armed, four-armed and multiple-armed arrangements by way of the permanent connection of the edges, for example, a "V" arrangement consisting of two plates, which are positioned at an angle of 60°, and a "Y" arrangement consisting of three plates, which are arranged at an angle of 120°, a cross arrangement, a six-armed arrangement, et cetera.

The plates 3 and the pipe profiles 10 can be made of metal, plastic, ceramic, carbon, and the like.

During materials and heat exchange processes, hot liquid is applied from above on the insert 1. The hot liquid flows downward over the walls of the plates 3 and like a cascade along the subsequent cutouts 7 and 8, so that it wets the surfaces and makes contact with the counterflow of flowing gas.

As a consequence of the inclination of the cutouts and also as a consequence of their different arrangement in the flow channels 6 and 6', a turbulent motion or a screw-spiral motion of the liquid and the gas is forced, which ensures a good mixing of the two phases and an increase of the materials and heat exchange also when the insert is acted on by small quantities of the gaseous phase.

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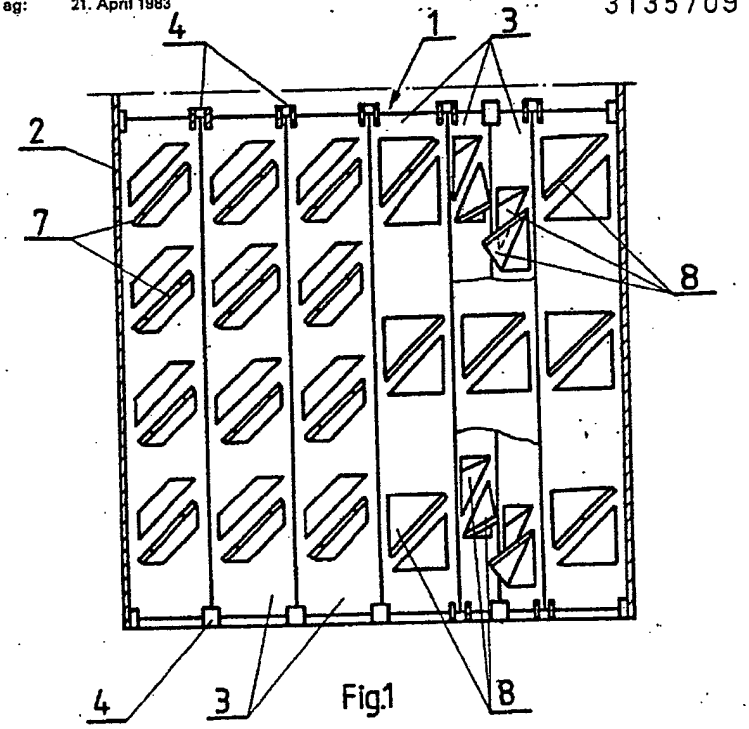

Fig.1

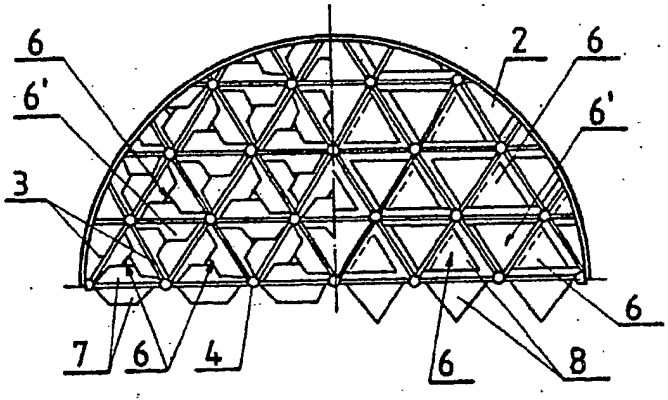

Fig.2

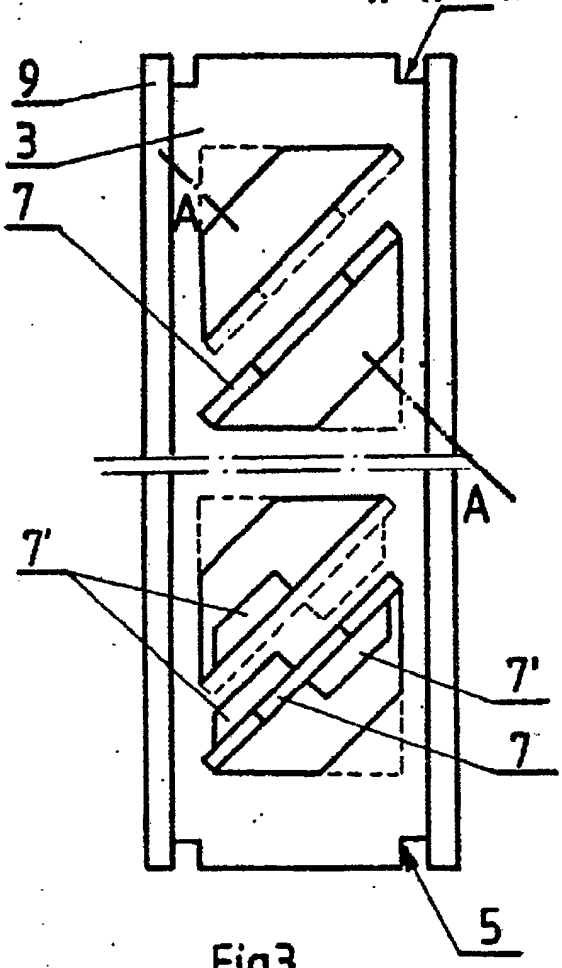

Fig.3

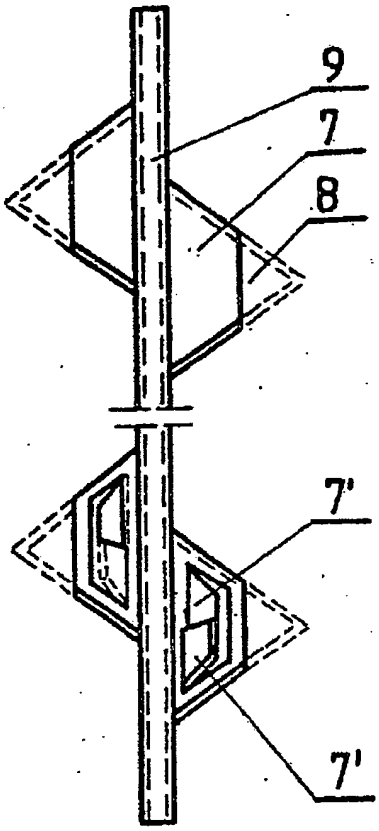

Fig.4

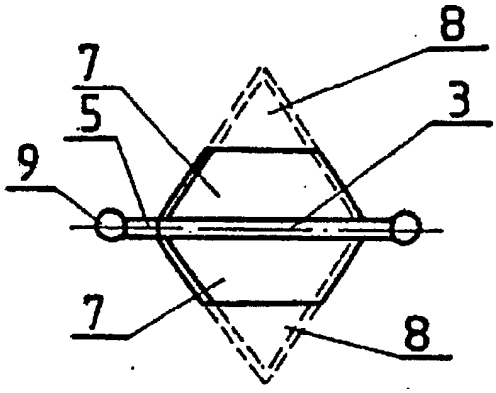

Fig.5

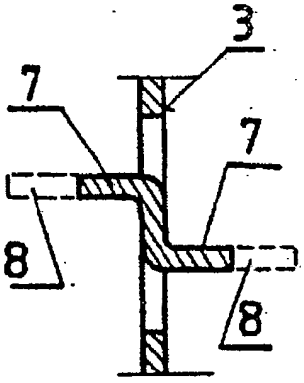

Fig.6

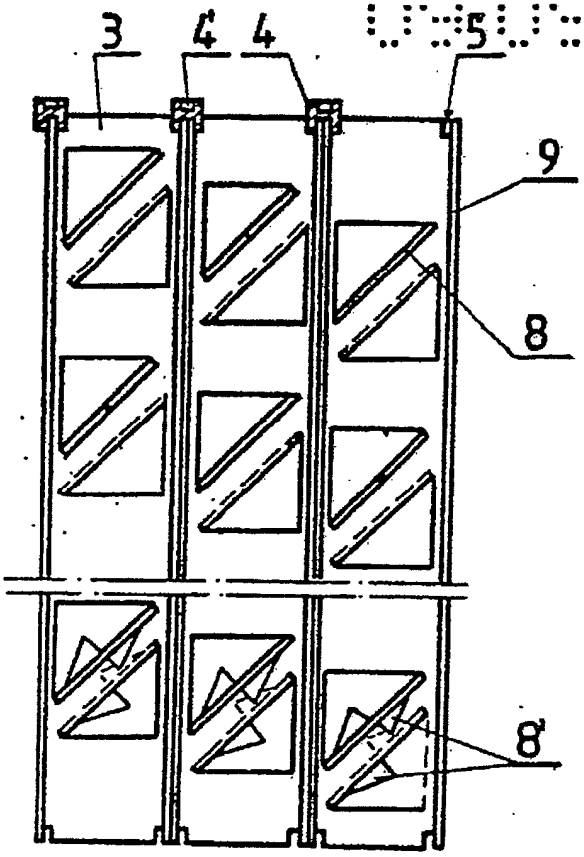

Fig.7

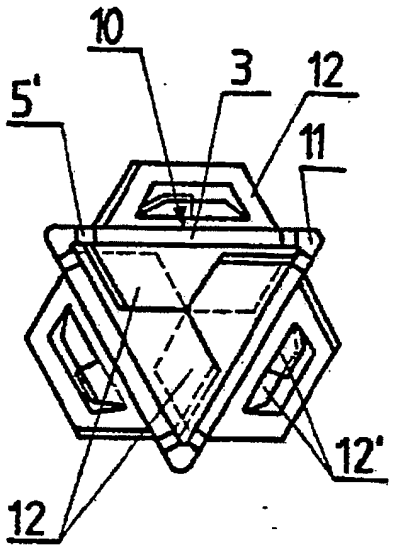

Fig.8

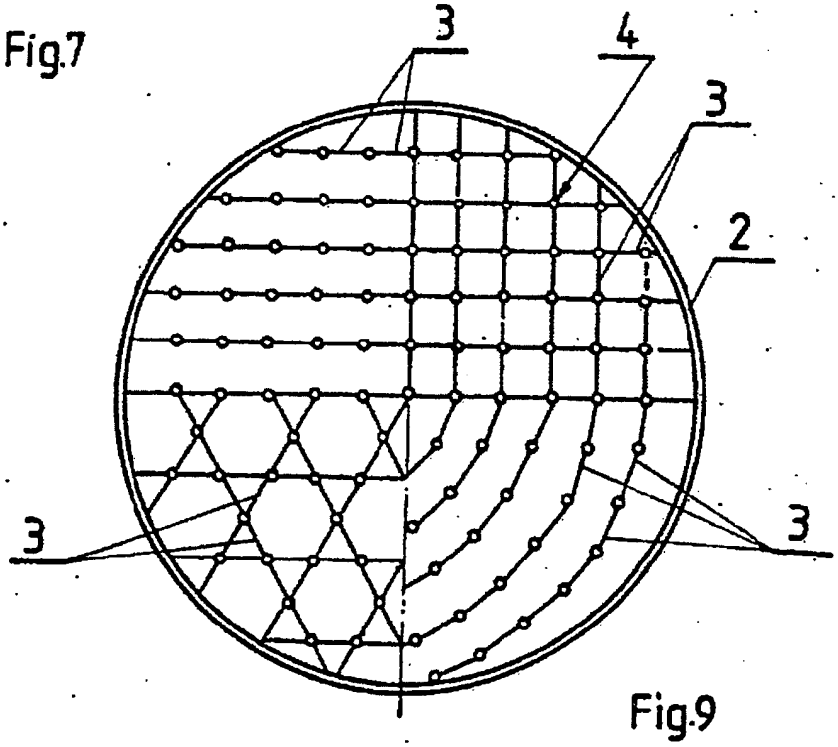

Fig.9